US-PAT-NO: 6271107

DOCUMENT-IDENTIFIER: US 6271107 B1

TITLE: Semiconductor with polymeric layer

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Brief Summary Text - BSTX (7):

Although flip chip bonding provides a number of advantages, flip chip bonding also presents a number of problems. For example, stenciling can be used to form solder bumps on chips to be flip chip bonded. In a typical stenciling process, a rigid **stencil** is placed on a semiconductor wafer having a number of chips. The **stencil** is disposed over the wafer so that the apertures of the **stencil** are aligned with pads on the individual chips. Solder paste is then deposited through the **stencil** apertures and onto the pads. The deposited solder is then reflowed to form solder bumps on the wafer. After reflow, the **stencil** is separated from the wafer. When the mask is separated from the wafer, the **stencil** may inadvertently contact one or more of the solder bumps dislodging them from the wafer. If this occurs, it may be necessary to rework the wafer to maximize the yield of bumped chips. Reworking wafers is expensive and time consuming. Although conventional photoimageable and strippable solder masks can be used in place of the rigid **stencil** described above, the use of solder masks requires additional process steps which increases the cost of the formed electrical assembly.

Detailed Description Text - DETX (26):

If the solder composition is in the form of a slurry, the slurry can be deposited within the apertures 18 by any suitable method including stenciling. Stenciling includes passing a blade such as a doctor blade over the surface of the release layer 16 with the slurry disposed along the leading edge of the blade. As the slurry passes across the surface of the release layer 16, some of the slurry 20 deposits into the apertures 18. Some slurry residue may remain on the outer surface of the release layer 16 after the stenciling procedure. The apertured release layer 16 acts as a **stencil,** thus controlling the amount of slurry deposited within the apertures of the polymeric layer 14.

Detailed Description Text - DETX (27):
Using a release layer as a **stencil** to deposit a slurry within the apertures provides several benefits. First, the release layer 16 protects the bonding surface of the polymeric layer 14 during the deposition of the slurry, thus preventing the slurry from contaminating the bonding surface of the polymeric layer. As explained previously, if the polymeric layer is to be used as an underfill material, contaminants present on the bonding surface of the polymeric layer can prevent the polymeric layer from adequately adhering to an adjacent circuit board. Second, in conventional stenciling processes, there is the potential for misalignment of the **stencil** during processing. For this reason, the diameter of **stencil** apertures are normally smaller than the diameter of the apertures in which the solder composition is deposited. However, in embodiments of the invention, the apertures in the release layer 16 are virtually perfectly aligned with, and have substantially the same diameter as, the underlying apertures in the polymeric layer 14.

Therefore, the minimum diameter of the polymeric layer apertures are not limited by the dimensions of the release layer apertures as would be the case with a removable **stencil**. The use of a release layer therefore enables the formation of smaller diameter and more densely packed solder bumps. Third, the release layer 16 can be at least 12.5 .mu.m thinner than the thinnest **stencil** currently available (25 .mu.m). Thinner stencils can be used to deposit the slurry into smaller apertures, which can result in the formation of smaller solder bumps. Fourth, the release layer 16 conforms to any non-planarities on the surface of a polymeric layer caused by the unevenness on the surface of the semiconductor substrate better than a conventional **stencil**. This reduces the variation in the amount of solder composition that is stenciled into the plurality of apertures 18. As a result, more uniform filling and better controllability are achieved with release layer 16, which are important factors for reliably forming high densities of small solder bumps. Fifth, conventional stencils are often used several times and tend to collect contaminants on their surfaces which can be later transferred to polymeric layer 14. As stated above, contaminants on the bonding surface of the polymeric layer 14 may prevent the tacky surface of the polymeric layer 14 from adhering to an adjacent surface.

Detailed Description Text - DETX (46):

Conventional underfill materials are deposited between the chip and the circuit substrate after the solder joints between these components are formed. The additional steps needed to add the underfill material can be time consuming and thus costly. In embodiments of the invention however, such additional steps are not required. As is apparent from the previous

discussion, the polymeric layer can be placed on the semiconductor substrate having plural chips, and can be used as a **stencil** to help deposit a slurry onto the conductive regions of a semiconductor substrate. This **stencil** can be left on the separated chips and can be used as an underfill material without performing a separate underfill material deposition step. Accordingly, embodiments of the invention provide for reduced processing steps, thus lowering the overall cost of the formed assembly.